

NEEDLE PUNCHED NON WOVEN OF *SESBANIA ACULEATE* (*DHAINCHA*) FIBRE

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ABSTRACT

The needle punched non woven fabric prepared from processed/treated *S. aculeata* (*dhaincha*) fibres was tested for physical properties namely, fabric weight, fabric thickness, abrasion resistance, fabric stiffness, tensile strength and elongation, tearing strength, bursting strength and air permeability.

KEYWORDS: Textile Testing, Indian Textile, Needle Punched

INTRODUCTION

The unconventional bast and leaf resources offer an opportunity to be exploited for producing textile fibres through their processing. Non woven has emerged as one such structure offering wide applications in different sectors. Non woven is a textile structure produced by interlocking of fibres accomplished by mechanical, chemical, thermal or solvent means, and combinations there of. This technique of fabric construction utilizes fibre for product development omitting the need of yarn production and its use for fabric production.

The needle punched non woven are formed by this technique and it can utilize natural as well as synthetic fibres. The product has lower cost of production, low bulk density, porous, better absorbency, less stiffness and better thermal insulation and biodegradable. This non woven fabric has found use in both domestic (home furnishing) as well as industrial sphere (automobiles, geotextiles and agro textiles).

One such potential sources of fibre in Uttarakhand state is *Sesbania aculeata*, locally known as *dhaincha*. The *dhaincha* plant belongs to *leguminacea* family, so it has nodules in its roots and these provide nitrogen content to the soil. It is grown for green manuring of the fields prior to cultivation of sugarcane and paddy crop in the fields. The stem and leaves serve as a source of organic matter for the soil by crushing entire plant in young stage in the fields. So the stem of this plant could be exploited to extract fibres and prepare eco friendly and biodegradable products to be used in agriculture sector in different practices.

The fibres obtained from *dhaincha* are harsh, coarse and shiny in appearance but lack elasticity. In some states, the fibre is extracted and utilized for making fish net and rope, sackcloth, sailcloth and cordages. Thus this fibre, owing to its characteristics, is not utilized for regular apparel fabrics but is used only for coarse structures. To diversify the end uses of this fibre, it can be used as a potential fibre for preparing non woven structure and has tested for its physical properties.

MATERIAL AND METHODS

Materials

Scoured and bleached *S. aculeata* (*dhaincha*) fibres were used for preparation of needle punched non woven fabrics.

Methods

Preparation of *S. aculeata* (dhaincha) Fibres

The *S. aculeata* (dhaincha) fibres extracted from retting period of 15 days, scoured with one per cent concentration of potassium hydroxide and bleached with hydrogen peroxide were best in terms of visual evaluation and values of physical properties in comparison to other agents and their concentrations. Hence retting period of 15 days, one per cent concentration of potassium hydroxide as scouring agent and hydrogen peroxide as bleaching agent were selected for the present research work.

Preparation of Non Woven Fabric

Non woven fabric was prepared from *S. aculeata* (dhaincha) fibres using needle punching method at OBEETEE Textiles Ltd., SIDCUL, and Pantnagar. The non woven fabric was prepared on needle punching loom that used Dilo technology of Germany based on Delta card system and had synchronization with PLC drives. It was a professional machine with diversified functions and continuous production line starting from feeding of fibres and ending with exit of final product of isotropic nature i.e., machine direction and cross direction. The machine parameters were maximum width of 3.5 metre, speed of 20 linear metre /min and needles density of 100 needles / linear density. The triangle needles having gauge 15×18×36 and length 3 1/2 inch were used. Punching was done in the scoured and bleached fibre web, to entangle the fibres directly with each other together. The water, air, heat and chemicals were not used in production. It was a kind of pure physical and mechanical bonding method. The needle punched non woven of *S. aculeata* (dhaincha) fibres was prepared by passing through the following steps -

Feeding

The *S. aculeata* (dhaincha) fibres were opened and spread on the floor for the preparation of fibres for carding. The fibres were fed to card into carding machine in predetermined quantity by electric auto scale controlled system.

Carding

The *S. aculeata* (dhaincha) fibres were fed into the carding machine as shown in Figure 1. There the fibres were trapped in the wires of the series of rotating cylinders and got aligned in an essential parallel direction (machine direction). A web or net was formed on card which was passed from the card by doffer to the cross lapper.

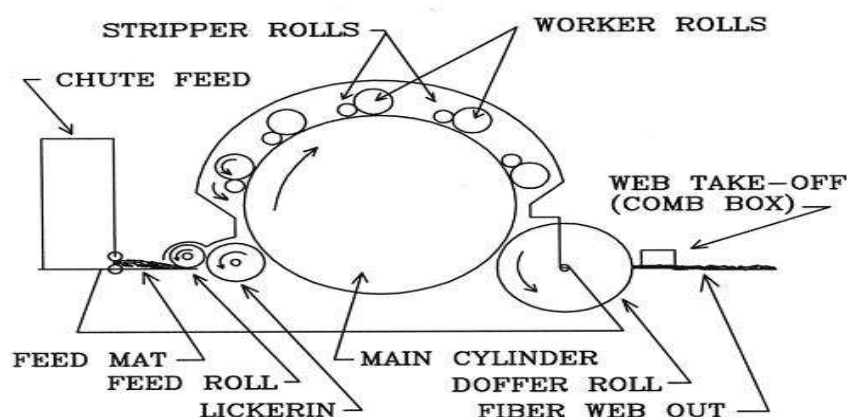


Figure 1: Parts of Carding Machine (Source: www.engr.utk.edu)

Cross Lapping

The *S. aculeata* (*dhaincha*) fibres' webs were cross lapped two times by cross lapper to increase the strength in cross direction, thickness, weight, width and uniformity of non woven fabric. It is shown in Figure 3.3 and Plate 7.

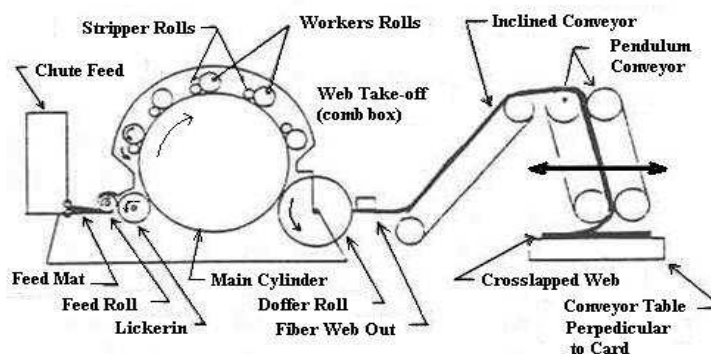


Figure 2: Vertical Cross Lapper (Source: www.engr.utk.edu)

Web Feeding

The layered web of *S. aculeata* (*dhaincha*) fibres formed by cross lapping was delivered to needle punching loom by means of web feeder. The web feeder prevented the layered web to get deformed.

Pre-Needle Punching

The layered web of *S. aculeata* (*dhaincha*) fibres was fed through a series of needle punching machines as shown in Plate 8. It started with the pre-needle punching that was done to interlace various layers using low needle density. It was a preliminary 3-D interlacing to entangle the fibres.

Needle Punching

The pre punched layered web of *S. aculeata* (*dhaincha*) fibres was delivered by means of conveyor belt and rollers through two needle punching looms placed back to back as loom I and loom II, where the web got needle punched successively to get the middle density non woven fabric of *S. aculeata* (*dhaincha*) fibres manufactured in the end.

PHYSICAL PROPERTIES PREPARED OF NON WOVEN FABRIC

Fabric Thickness (IS: 7702-1975)

The thickness of non woven fabric sample was determined by using fabric thickness gauge¹.

Fabric Weight (IS: 2387-1969)

The test method for measuring fabric weight as given¹ was followed to examine the fabric weight of prepared non woven *S. aculeata* (*dhaincha*) fabric samples.

Tensile Strength (IS: 1969-1968) and Elongation

Ravelled strip test method as given¹ was used to test the tensile strength and elongation of prepared non woven fabric.

Tearing Strength (IS: 6489-1971)

The tearing strength test was carried out by using the standard method given¹.

$$\text{Tearing strength (gm)} = \frac{\text{Pointer reading} \times \text{Capacity of instrument}}{100}$$

Bursting Strength (IS: 1966-1965)

Bursting strength is the strength of fabric against a multidirectional flow of pressure².

Fabric Stiffness (IS: 6490-1971)

Fabric stiffness (bending length) of the fabric was measured as per the procedure given¹. The stiffness or bending length of the non woven *S. aculeata (dhaincha)* fabric was calculated by using following formula-

$$\text{Bending length (C)} = L/2 \text{ cm}$$

Where,

L = Mean length of over hanging portion in cm

Abrasion Resistance

The Martindale abrasion tester was used according to the method described by³. Abrasion resistance was expressed in percentage weight loss as calculated by the given formula-

$$\text{Abrasion loss(per cent)} = \frac{\text{Wt. of sample before abrasion} - \text{Wt. of sample after abrasion}}{\text{Wt. of sample before abrasion}} \times 100$$

Air Permeability (ASTM D737)

Air permeability of the fabric was assessed the standard method given⁴ by using air permeability tester.

RESULTS AND DISCUSSIONS

The prepared non woven fabric was tested for physical properties namely, fabric weight, fabric thickness, abrasion resistance, fabric stiffness, tensile strength and elongation, tearing strength, bursting strength, air permeability and water absorption and the results are presented in Tables 1 and 2.

Table 1: Physical Properties of Non Woven *S. aculeata (dhaincha)* Fabric

Sl. No	Property	Min	Max	Average
1.	Fabric weight (g/m ²)	613	630	616
2.	Fabric thickness (mm)	4.6	7.97	6.28
3.	Abrasion loss (per cent)	9.4	11.18	10.3
4.	Air permeability (m ³ /m ² /m)	241	250	245
5.	Bursting strength (kg/cm ²)	5.0	8.0	6.5

It is evident from data in Table 4.10 that the fabric weight of non woven *S. aculeata (dhaincha)* fabric was between 613 g/m² and 630 g/m² with an average of 616 g/m². Also the fabric thickness of non woven *S. aculeata (dhaincha)* fabric ranged between 4.6 to 7.97 mm with an average of 6.28mm. The result are in accordance to the finding of ⁵ who reported that the jute non woven prepared by needle punching machine had fabric thickness of 4.70 mm. That⁶ had also reported that non woven prepared by needle punching method had less weight with more bulk.

It can be envisaged from data in Table 4.9 that the non woven *S. aculeata* (dhaincha) fabric made with needle punching method had an average abrasion loss of 10.3 per cent. Abrasion loss was more in non woven *S. aculeata* (dhaincha) fabric because it was made merely by the entanglement of the fibres without any subsequent finish like resin coating which could make it more abrasion resistant.

It is evident from Table 4.10 the average value for air permeability and bursting strength of non woven *S. aculeata* (dhaincha) fabric were $245 \text{ m}^3/\text{m}^2/\text{m}$ and $6.5 \text{ kg}/\text{cm}^2$, respectively. Thus the non woven *S. aculeata* (dhaincha) fabric had high air permeability and good bursting strength.

The fabric stiffness, tensile strength and elongation, tearing strength and bursting strength of non woven *S. aculeata* (dhaincha) fabric were assessed in both machine as well as cross direction and are presented in Table 2.

Table 2: Physical Properties of Non Woven *S. aculeata* (dhaincha) Fabric

S. No	Properties	Fabric Direction	Min	Max	Average
1.	Tensile Strength (kg)	Machine direction	4	7	5.6
		Cross direction	23	25	24
2.	Elongation (%)	Machine direction	45	49	47.2
		Cross direction	19	22	20.6
3.	Tearing strength (g)	Machine direction	2560	2880	2713.6
		Cross direction	2880	3520	3161.6
4.	Stiffness (cm)	Machine direction	2.65	3.15	2.95
		Cross direction	3.15	3.45	3.25

It is evident from Table 2 that the tensile strength, tearing strength and stiffness of non woven *S. aculeata* (dhaincha) fabric was more in cross direction as compared to the machine direction. The average tensile strength was 5.6 kg in machine direction and 24 kg in cross direction; average tearing strength of non woven was 2713.6 g in machine direction whereas in cross direction it was 3161.6 g. The higher tensile strength and tearing strength in cross direction than machine because the fabric structure was more consolidated in cross direction than in machine direction resulting in less slippage of fibres in cross direction than machine direction of non woven. The structure of non woven fabric was the most important factor affecting the tensile behaviour of the fabric. Besides it the slippage of the fibres was considered the dominating factor in determining strength in non woven fabric prepared by needle punching method also stated that by⁶.

It is also clear from data in Table 2 that the average elongation of the non woven *S. aculeata* (dhaincha) fabric was 47.2 per cent in machine direction whereas in cross direction it was 20.6 per cent. Thus the elongation in non woven fabric was found to be more in machine direction than in cross direction. It may be because of the fact that the strength of non woven fabric in cross direction was more than the strength in machine direction which is inversely related to elongation. The above explanation is in validation with the findings of ⁵ and ⁷. They also reported that as the strength of non woven increased elongation decreased and *vice versa*.

The data in Table 4.11 depicts that the stiffness of non woven *S. aculeata* (dhaincha) fabric made by needle punching method ranged between 3.15 to 3.45 cm with an average of 3.25 cm in cross direction whereas in machine direction it was found between 2.65 and 3.15 cm with an average of 2.95 cm, respectively. The higher value of stiffness in cross direction than in machine direction may be due to the higher density of fibres in that direction resulting in more compact and stiff fabric in the cross direction.

CONCLUSIONS

The non woven *S. aculeata (dhaincha)* fabric prepared from processed fibres had 616 g/m² fabric weight, 10.3 per cent abrasion loss, 245 m³/m²/m air permeability and 6.5 kg/cm² bursting strength. Also, its tensile strength, tearing strength and stiffness were more in cross direction as compared to the machine direction and vice versa in case of elongation. The prepared *S. aculeata (dhaincha)* non woven fabric could be used for numerous end uses in the agriculture sector.

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